Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
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Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions	)	ET Docket No. 12-268
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COMMENTS OF WHITESPACE ALLIANCE

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SUMMARY

Through the notice of proposed rulemaking in the captioned proceeding (the "Incentive Auction NPRM") and its implementation of the Middle Class Tax Relief and Job Creation Act of 2012 (the "Spectrum Act"), the Commission will adopt rules for (1) the conduct of a reverse auction in which broadcast licensees may submit bids to give up spectrum usage rights, (2) the repacking of remaining broadcasters to free up additional spectrum in the UHF band, and (3) the conduct of a forward auction of newly available spectrum to allow for licensed flexible wireless broadband use.

Among other things, the rules adopted through the Incentive Auction NPRM will impact the continued availability of white spaces in the TV bands for the deployment and use of white space devices, which were authorized by the FCC in the TV white space proceeding. There, the Commission designated the TV bands for unlicensed use in available spectrum in the band, known as white spaces, and adopted associated technical rules for the operation of white space devices in order to protect licensed broadcast TV and other protected operations.

White Space Alliance ("WSA") is a global organization that promotes the development, deployment and use of products and services in the U.S. and globally that exploit white space technologies as a means to maximize spectrum utilization for a wide variety of applications. WSA urges the Commission, in its implementation of the Spectrum Act and the Incentive Auction NPRM, to take specific steps to maximize the white space spectrum available in the reconfigured broadcast band for unlicensed white space use, and to authorize opportunistic use of licensed, but unused spectrum, by cognitive unlicensed devices in the television bands. WSA supports the adoption of rules for the reconfigured TV bands that foster the continued and robust deployment and use of white space devices in the TV bands and urges the Commission to

continue to recognize the benefits of unlicensed network operations in TV white spaces as it adopts rules for the incentive auction and reconfigured TV bands.

In opening up the TV bands for white spaces, the Commission recognized the unique and substantial benefits that the unlicensed use of white spaces in the television bands would bring as a form of "super Wi-Fi", both in services and applications, as well as in spectral efficiency. In the two years since the Commission's initial order on reconsideration in the white spaces proceeding and following the Commission's leadership and the promise of white space deployment, the interest in white spaces in the U.S. and abroad has exploded. Numerous companies are piloting white space projects as well as beginning commercial deployments, as described in these comments and in Attachment A, which provides a number of recent examples of white space deployment activities. The importance and potential for unlicensed white space deployments in the television band must also be viewed in the context of the provision of unlicensed spectrum for Wi-Fi, which has resulted in extraordinary commercial investment, technical innovation, and economic benefit, as well as achieving the highest level of spectrum utilization.

In the broadcast bands, the Commission's white space rules have set the stage for extremely robust white space deployments, with the availability of significant spectrum for white space use in markets around the country, particularly in rural, underserved, and unserved areas. As will be seen through these comments, the adoption of rules for the incentive auction, broadcast repack, and forward auction presents the Commission with significant opportunities, consistent with its statutory authority and the Spectrum Act, to maximize the availability of spectrum in the broadcast bands for white space use beyond the limited proposals in the Incentive Auction NPRM. To the same extent that its innovation, creativity and its forward

thinking led to the creation of unlicensed TV band white spaces use in the first place, given the significant promise of white space deployments, the fact that TV band white space databases are authorized and in place with rules for devices and deployments specifically designed and tailored for the TV bands, and that numerous companies are today investing and poised to launch new white space systems in the TV bands, the Commission must ensure the continued availability of significant swaths of contiguous spectrum in markets around the country to support the deployment of white space devices.

As discussed more fully in these comments, this can be accomplished, consistent with the Commission's statutory authority, in the following manner:

- The Commission should authorize opportunistic, "use it or share it" access to spectrum in the broadcast bands, including both unassigned licensed spectrum and spectrum that has been licensed but remains unused.
- The Commission should adopt the band plan set forth in Figure 12 of the NPRM to maximize the contiguous spectrum available to all users.
- It should allow the unlicensed use of the guard bands and duplex gap, and set the guard bands at 10 – 12 MHz and the duplex gap at 18 - 24 MHz.
- Rather than auctioning new wireless licenses for a specific channel assignment, which would fragment spectrum and reduce the availability of contiguous blocks for unlicensed white space use, in each geographic license area specific channels should be assigned to winning bidders at the time of deployment, and the band should be populated contiguously, to first occupy the available slots furthest from the duplex gap specified in Figure 12 of the NPRM. This will reduce spectrum silos which can reduce available white space and spectrum utilization.
- The Commission should make Channel 37 available for unlicensed white space device use, while continuing to protect Radio Astronomy Service and Wireless Medical Telemetry System users through registration in the white space database.
- Fixed white space operations should be permitted with a separation of only 3 MHz from an active TV channel, rather than the current prohibition of operations on an adjacent channel. This will enable the use of double channels, rather than three adjacent channels ("triplets") as is now required, and will also double the capacity of triplets.
- Effective broadcast deployment rules should be developed and refined to maximize spectrum utilization so as to increase the availability of spectrum for white space deployments.

- The Commission should take a number of actions to promote more efficient and effective operations of wireless microphones in the broadcast bands. These include: requiring wireless microphones to transition to more spectrally efficient modulation and bands; making available the two designated wireless microphone channels for unlicensed use, and providing for the sunset of their availability for wireless microphone use; providing for the continued registration in the white space data base of licensed Part 74 microphones and unlicensed microphones that the Commission has authorized to register; and requiring wireless microphones to first use channels unavailable for white space use, before using white space channels.

TABLE OF CONTENTS

Page

Before the
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In the Matter of	)	
	)	
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COMMENTS OF WHITESPACE ALLIANCE

WhiteSpace Alliance ("WSA") respectfully submits its comments in response to the Notice of Proposed Rulemaking of the Federal Communications Commission ("FCC" or "Commission") in the captioned proceeding.[1]

I. INTRODUCTION

Through the Incentive Auction NPRM, the Commission seeks to implement the television broadcast spectrum provisions of the Middle Class Tax Relief and Job Creation Act of 2012,[2] which directs the Commission to (1) conduct a reverse auction in which broadcast licensees may submit bids to give up spectrum usage rights, (2) repack the remaining broadcasters to free up additional spectrum in the UHF band, and (3) conduct a forward auction of newly available spectrum to allow for licensed flexible wireless use. Among other things, the NPRM asks for comment on numerous issues that will impact the continued availability of white spaces in the TV bands for the deployment and use of white space devices, which were

[1] Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions, Docket No. 12-268, Notice of Proposed Rulemaking, FCC No. 12-118 (Oct. 2, 2012)("Incentive Auction NPRM" or "NPRM").

[2] Pub. L. No. 112-96, §§ 6401, *et seq.*, 125 Stat. 156 (2012) ("Spectrum Act").

authorized by the FCC in the TV white space proceeding.[3] There, the FCC designated the TV bands for unlicensed use in available spectrum in the band, known as white spaces, and adopted associated technical rules for the operation of white space devices in order to protect licensed broadcast TV and other protected operations.

WSA, which is a global organization that promotes the development, deployment and use of products and services in the U.S. and globally that exploit white space technologies as a means to maximize spectrum utilization for a wide variety of applications, urges the Commission to take specific steps to maximize the white space spectrum available in the reconfigured broadcast band for unlicensed white space use, and to authorize opportunistic use of licensed, but unused spectrum, by cognitive unlicensed devices in the television bands.[4] Maintaining TV spectrum for unlicensed white space device use, in addition to auctioning spectrum for licensed commercial wireless use, will spur unique innovations to address better the meaningful communications needs of consumers, businesses and government agencies. As the Commission recognizes in the NPRM, unlicensed use supports a wide variety of public and private services for consumers and businesses at generally lower cost than presently available mobile broadband services.[5] New white space unlicensed technologies will foster competition and innovation, and improve the diversity of communications infrastructure, which is essential at times of emergency

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[3] NPRM, ¶¶ 227-229. *See* generally Unlicensed Operation in the TV Broadcast Bands, Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band, *First Report and Order and Further Notice of Proposed Rule Making*, 21 FCC Rcd 12266 (2006); *Second Report and Order and Memorandum Opinion and Order*, 23 FCC Rcd 16807 (2008)("*Second White Spaces Report and Order*"); *Second Memorandum Opinion and Order*, 25 FCC Rcd 18661 (2010) ("*Second White Spaces Reconsideration Order*"); *Third Memorandum Opinion and Order*, 26 FCC Rcd 3692 (2011)("*Third White Spaces Reconsideration Order*").

[4] *See also* Ex Parte Letter of WhiteSpace Alliance Endorsing License-Exempt Usage of the Television Band White Spaces, in Docket No. 04-186 (filed Sept. 10, 2012). In these comments, WSA will focus primarily on aspects of the NPRM that impact unlicensed operations in the reorganized spectrum envisioned in this proceeding. Except where indicated, WSA has no comment on the particulars of the auctions and related issues.

[5] NPRM, ¶ 228.

to aid disaster recovery. White space technologies will also assist commercial wireless providers, serving as an important new source of broadband capacity for offloading network traffic and reducing network congestion.

IEEE 802,[6] has already published standards for white space devices and is in the process of completing additional amendments to standards which support additional operation in the TV broadcast bands under the Commission's Part 15 rules. These standards and amendments support applications which include broadband wireless access and hotspots in rural, remote, and other types of areas, wireless local area network operations, including home, business applications and cellular data offload applications, and machine to machine ("M2M") operations, including smart grid and smart metering applications. Hence, unlicensed TV white space device use in the TV bands will support applications in healthcare, education, smart utility networks, disaster recovery, environment monitoring, critical infrastructure monitoring, border protection, homeland security, high speed internet, among others.

As discussed below, and reflected in Attachment A, there are already numerous white spaces success stories in the U.S. and throughout the world, reflecting the emergence of a robust white space ecosystem based on the Commission's white space regime, comprised of technology companies, equipment manufacturers, wireless providers, and governmental entities. Given the TV bands' favorable propagation characteristics, improved building penetration and resulting enhanced regional and rural coverage, with the adoption of appropriate rules in this proceeding, TV white space deployments are poised to be become increasingly vital across numerous industries and sectors.

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[6] The IEEE Local and Metropolitan Area Networks Standards Committee ("IEEE 802").

As the Commission recognizes, unlicensed spectrum use contributes to our economy not only through the sales of unlicensed products themselves, but also through collateral commercial activities that they facilitate.[7] Significant innovations in wireless communications such as IEEE 802.11 (Wi-Fi), and IEEE 802.15.1 (Bluetooth) were born in the spectrum bands without the need for any exclusive license. At the same time, commercial mobile wireless providers use other wireless networks, such as Wi-Fi, that operate in unlicensed spectrum to enhance their services and save costs. This reduces congestion, provides network redundancy and high data rates to ensure service quality in a cost-effective manner.

WSA urges the Commission to continue to recognize the demonstrated benefits of unlicensed spectrum use, such as unlicensed use of television white spaces. Unlicensed spectrum supports a wide variety of public and private services for consumers and businesses providing alternate means of broadband delivery. For this reason, in apportioning the frequency band between licensed and unlicensed uses it is important to make certain that a substantial amount of spectrum is kept available for unlicensed TV white space use, and WSA urges the Commission to ensure the continued availability of significant contiguous blocks of spectrum for unlicensed operation in the TV bands.

This includes to the maximum extent possible under its existing authority, and authority under the Spectrum Act, to maximize the availability of unlicensed spectrum, make contiguous blocks of at least three, 6 MHz channels available for unlicensed use in the TV broadcast bands, particularly in rural, unserved and underserved markets, and to authorize the opportunistic use of both unlicensed and licensed, but *unused* channels by white space technologies. *To be clear, WSA agrees with the FCC that spectrum should not remain unused if there are radio*

[7] NPRM, ¶ 228.

technologies that can make use of the spectrum that may be licensed but unused, while preserving the established regulatory framework for the use of the TV frequency bands. In this manner, the Commission will foster the demonstrated benefits of unlicensed spectrum operations, and specifically those of white space technologies that it has continuously recognized, including as engines of technological innovation and competition in broadband markets.

II. BACKGROUND

A. WhiteSpace Alliance and its Interest in This Proceeding.

WSA (www.whitespacealliance.org) is a global organization that promotes the development, deployment and use of products and services in the U.S. and globally that exploit white space technologies as a means of efficiently using underutilized spectrum to provide advanced broadband capabilities. WSA promotes the opportunistic use of licensed spectrum by unlicensed cognitive radios, that with geo-location databases (or together with sensing technologies and beaconing approaches), can operate on vacant, unassigned frequencies (as is the case at present in the U.S. with television white spaces), as well as on frequencies that may be licensed but are not in use. In addition, WSA also supports the maximum availability of unlicensed spectrum in licensed bands, which, together with vacant and unused channels in these bands, can provide additional bandwidth necessary to support robust broadband communications.

WSA also supports the development and deployment of standards-based white space products and services as an enabler of an emerging and robust white spaces ecosystem. These include the use of the IEEE 802.22 (Wi-FAR™), 4G-WhiteSpace™, and IETF PAWS standards.

For example, the WhiteSpace Alliance Wi-FAR specification will allow for the deployment of wireless regional area networks (or "WRANs") that with current technology can deliver a wireless broadband connection over 30 km (19 miles) from the base station, and provide speed of up to 22 Mbps using a standard 6 MHz TV channel. In addition, the IETF[8] is likewise developing a standard protocol to access the white space database, and there are numerous other ongoing standardization activities for a wide variety of applications using TV white spaces.[9] WSA estimates that more than $100 million has been invested by various companies and organizations to participate and create these inter-operability specifications.

WSA is developing and adopting numerous such standards for a wide variety of applications including regional and rural broadband access, smart grid, cellular offload and hotspot support, healthcare, and others within the regulatory framework established by the Commission for TV white spaces. WSA will also engage in interoperability and conformance testing of white space devices and associated certification in order to provide low cost, reliable equipment for consumers in the U.S. and globally.

Given its interest in a vibrant and robust white space industry, and as the membership organization of companies developing and deploying white space-based technologies, equipment, and networks, WSA has a direct and substantial interest in this proceeding, as the rules the Commission adopts in this proceeding will directly impact the availability of spectrum in the television bands for white space technologies.

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[8] The Internet Engineering Task Force, which is considering a standardized protocol for accessing white spaces data bases (known as the Protocol to Access White Spaces Data Bases or "PAWS"), in order to achieve interoperability among multiple White Spaces devices and databases. *See* *http://datatracker.ietf.org/wg/paws/*.

[9] These include, for example, IEEE 802.11af (Wireless Local Area Networks), IEEE 802.15.4m (Wireless Personal Area Networks), IEEE 802.19.1 co-existence in TV Band White Spaces, and IEEE DySPAN (Dynamic Spectrum Access Network), among others.

B. The Commission's Authorization of Unlicensed White Space Use in the Television Bands

In a series of orders, culminating in the orders on reconsideration in 2010 and 2011, the Commission adopted rules making unused spectrum in the TV bands available for unlicensed broadband wireless devices.[10] Specifically, the rules provide for the operation of unlicensed transmitting devices in the television broadcast bands (which the Commission termed unlicensed TV band devices, and are now referred to as white space devices) on frequencies that are not used by licensed services. These unused TV band frequencies are known as "TV white spaces."[11]

TV stations operate on 6 MHz channels in three VHF bands (54-72 MHz, 76-88 MHz, and 174-216 MHz), comprising channels 2-13, and in the UHF band (470-698 MHz), comprising channels 14-51. In eleven major metropolitan markets, up to three channels between channels 14 – 20 (470 MHz – 606 MHz) are used by private land mobile or commercial wireless licensees. Channel 37 in the UHF band is allocated for radio astronomy and the wireless medical telemetry service (WMTS) and is not used for TV broadcasting. In addition to full service TV stations, other licensed operations in the TV bands include Class A TV stations, as well as several licensees that operate on a secondary basis to full power TV stations, including low power TV stations, TV translator and TV booster stations. Wireless microphones are also permitted to operate on vacant TV channels on a non-interference basis.

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[10] *See n. 3, supra.*

[11] In order to avoid interference, significant geographic separation is maintained between full service stations on adjacent channels and co-channels. Consequently, there are typically a number of TV channels in a given area that are not being used by full service TV stations in order to avoid interference to co-channel or adjacent channel stations. In addition, in many areas, otherwise available channels are unlicensed. Given lower antenna heights and power level of unlicensed devices, as the Commission recognized in authorizing white space devices, at appropriate power levels and antenna heights, these devices can operate without causing harmful interference to licensed TV stations.

In general, the white space rules permit unlicensed devices to operate on TV channels that are not in use in their vicinity, subject to specific technical requirements that are intended to prevent interference to TV broadcasting and other authorized users of the TV bands. The Commission adopted technical criteria for determining when a TV channel is considered vacant for the purpose of allowing operation of an unlicensed device on that channel, protecting full service TV stations and Class A TV, low power TV, TV translator and TV booster stations from interference within defined signal contours for those stations.[12] It also protected digital low power television stations to the same signal contour as full service digital TV stations.[13]

The Commission permitted both fixed and personal/portable unlicensed devices to operate in the TV bands. Fixed devices may operate at up to 4 Watts Effective Isotropic Radiated Power ("EIRP"). The Commission permitted fixed devices to operate on any channel between 2 and 51 (with the exception of channels 3, 4 and 37, the latter being reserved for radio astronomy and WMTS). Of particular significance to the continued viability of white space technologies in the reconfigured broadcast bands, the Commission restricted fixed operations on co-channel and adjacent channels to a TV station, effectively requiring three contiguous channels (sometimes called a "triplet") for fixed white space operations. In contrast to fixed devices, personal portable devices may only operate on unoccupied channels between channel 21 and 51, and may use up to 100 milliwatts EIRP. However, portable operations on the first adjacent channels to TV stations are limited to 40 milliwatts EIRP. This significantly reduces the operational capabilities of portable devices on adjacent channels, in practice, increasing the need for a triplet for portable use, as is the case for fixed devices. In addition, in 13 major markets

[12] 47 C.F.R. § 15.712(a)(1).

[13] *Id.*, § 15.712(a)(2).

where certain channels between 14 and 20 are used for land mobile operations, two channels around channel 37 (if a channel is not available above and below channel 37, the first two channels nearest to channel 37) were kept free of unlicensed devices and are available exclusively for wireless microphones.

The Commission adopted a geo-location data base model to ensure that TV white space devices do not interfere with licensed operations. Essentially, the rules provide for the authorization of one or more privately owned and operated database services that unlicensed TV bands devices must contact to obtain information on channel availability at the locations where they are operated and, in the case of fixed devices, to register their operation at those locations.[14] In general, all fixed devices must contact a database to determine channel availability. Portable devices may operate on available channels either as a "slave" to a fixed device that identifies available channels (what is referred to as Mode I operation), or by querying the database directly for available channels (referred to as Mode II operation).

[14] TV white spaces databases are required to maintain information on, among other things: 1) all of the authorized services that operate in the TV bands using fixed transmitters with designated service areas, including full service and low power TV stations, 2) the service paths of broadcast auxiliary point-to-point facilities, 3) the geographic regions served by PLMRS/CMRS operations on channels 14-20, 4) regions served by the Offshore Radiotelephone Service, 5) the locations of cable headends/multichannel video programming distributor receive sites and low power TV receive sites that are outside the protected contours of the TV stations whose signals they receive, and 6) licensed wireless microphones and unlicensed wireless microphones eligible for registration.

III. IN IMPLEMENTING THE SPECTRUM ACT, THE COMMISSION MUST CONSIDER THE HUGE POTENTIAL BENEFITS OF UNLICENSED WHITE SPACE DEPLOYMENTS.

A. The Commission's White Space Rules Set the Stage for the Deployment of Powerful New Wireless Broadband Services in the Broadcast Bands, Particularly in Unserved and Underserved Rural Markets, the Efficient Use of Broadcast Spectrum, and Substantial New Competition in the Provision of Broadband Services.

In opening up the TV bands for White Spaces in 2008, the Commission recognized the unique and substantial benefits that the unlicensed use of white spaces in the television bands would bring. Key among these benefits were the following:[15]

- Unlicensed white space use would enable the development and operation of a wide range of new unlicensed wireless communications devices and systems in spectrum where signals are less subject to propagation losses than they are in the bands currently available for such devices;
- The propagation advantages of this spectrum would make it possible for Wireless Internet Service Providers (WISPs) and others to improve or extend their reach to customers in rural and other less densely populated area;
- The deployment of new white space technologies would have economic benefits for consumers and businesses by facilitating the development of additional competition in the broadband market.

Two years later, in its *Second White Space Reconsideration Order,* the Commission touted the promise and huge benefits from the unlicensed use of TV white space in the television bands under its new rules. For example, the Commission recognized the ability of the broadcast bands to support what it termed "Super Wi-Fi" – "more powerful public Internet connections . . . with extended range, fewer dead spots, and improved individual speeds as a result of reduced congestion on existing networks."[16] It also recognized that "the potential uses of this spectrum are limited only by the imagination," recognizing white space suitability for educational, rural,

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[15] *Second White Spaces Report and Order,* ¶ 32.

[16] *Second White Spaces Reconsideration Order,* ¶ 1.

home, and machine-to-machine uses, "such as broadband access to schools particularly in rural areas, campus networks that are better able to keep pace with user's increasing demands for bandwidth, home networks that are better able to support real time streaming video applications, remote sensing of water supplies by municipalities and support for the smart grid."[17] And the Commission also recognized the huge spectral efficiencies that white space use would bring, not only in the television bands, but, critically, as a test bed for opportunistic use in other bands through the use of database driven cognitive technologies:[18]

> Although the particular unused TV channels vary from location to location, the devices will have the flexibility and agility to locate and operate on the unused channels, no matter where the devices are located. . . . This type of "opportunistic use" of spectrum has great potential for enabling access to other spectrum bands and improving spectrum efficiency. Our actions here are expected to spur investment and innovation in applications and devices that will be used not only in the TV band but eventually in other frequency bands as well.

Unlicensed white space use in the TV bands can support high speed internet applications such as regional area networks, healthcare, education, smart utility networks, disaster recovery, environment monitoring, critical infrastructure monitoring, border protection, homeland security, and other countless innovative areas. For example, when the Commission adopted its *Second White Spaces Reconsideration Order* in 2010, it noted that even at that time, a number of TV bands device applications were operating on an experimental basis.[19] At that time, the city of Wilmington North Carolina also was trialing "Smart City" applications, including public "hot spots," low-cost broadband to a low-income housing development, and water level and water purity sensors for compliance with Environmental Protection Agency requirements and flood controls. In addition, a demonstration project in Claudville Virginia was bringing broadband

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[17] *Id.*

[18] *Id.*

[19] *Second White Spaces Reconsideration Order*, ¶ 14.

access to a rural elementary school, as well as to consumers in their homes, and newly established public hot spots in the community. And Plumas County California has undertaken a "Smart Grid" trial for electricity networks, which allows the electric cooperative to manage the electrical system, obtain data from substations, and manage power flow.[20]

In the two years since the order on reconsideration, following the Commission's leadership and the promise of white space deployment, the interest in white spaces in the U.S. and abroad has exploded. For example, since that time the Commission has conditionally certified Spectrum Bridge and Telcordia Technologies as white spaces database administrators. And following public testing of their database systems, the Commission has authorized SpectrumBridge and Telecordia to operate their TV bands database systems and provide service to the public. At present, there are numerous additional innovative, cutting edge white space deployments around the country and internationally, examples of which are described in Attachment A, hereto.

The leadership and rules of this Commission, UK's OfCom and Industry Canada on TV white spaces has been touted as visionary, and educational outreach programs are being conducted around the world building on these TV white space rules. WSA has been actively organizing workshops to educate local leaders on various technologies available and their applications that could benefit their populace. One such workshop was recently conducted in India,[21] with additional workshops planned in Brazil, South Africa and numerous other countries.

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[20] *Id.*

[21] *See* TV White Spaces and Cognitive Radio Workshop, Mumbai India, available at http://www.ee.iitb.ac.in/~tvwscr/index.html.

B. Unlicensed Spectrum Use Has Been a Key Economic Driver, and Serves as an Important Example of the Benefits that Will Flow from White Space-Friendly Implementation of the Spectrum Act.

WSA would like to promote an open discussion of the key business drivers involved in spectrum allocation. There should be a pragmatic "Return on Investment" (ROI) mind set when considering these policy options which will undoubtedly have broad impacts on the U.S. economy.

The following key questions should be asked:

- Which policies are likely to meet the goal of bringing broadband access to remote and rural communities around the U.S. and support applications such as smart grid and machine-to-machine applications at reasonable price points?
- Which policies are likely to generate the greatest economic value for the American people, and for all businesses including thousands of small businesses across the U.S. that are using and providing wireless internet services?
- Which policies are likely to create entrepreneurial success stories for small businesses in cities and towns as well as remote rural areas?
- Which policies will stimulate the greatest innovation and commercial investments needed for rapid deployment of infrastructures to meet the staggering demand for wireless data services?
- Can these policies meet not only the short term fiscal goals of Congress but also the long term spectrum utilization needed for our wireless communication infrastructure?

To answer these questions one should look to the return on investment of previous spectrum policy initiatives in terms of investment cost, innovation, economic impact and spectrum efficiency as a guide.

Clearly, on the top of the list of successful policies has been the unlicensed spectrum for the Wi-Fi IEEE 802.11 standard, which has required very little investment in regulations or management but has resulted in extraordinary commercial investment, technical innovation and

economic benefit as well as achieving the highest level of spectrum utilization.[22] The simplicity of Wi-Fi use in unlicensed bands has created huge opportunities for small businesses to create innovative business models around providing wireless Internet services. IEEE 802.11-based Wi-Fi is generating more than $50 billion per year to the U.S. economy alone, serving the needs of more than 110 million Americans.[23] Failing to meet the needs of this growing demand for unlicensed use by even 10% would result in the loss of $100 billion in tax revenue in just a single decade.[24] It has become so essential to our communications infrastructure that wireless carriers reportedly rely on Wi-Fi to offload over 50% of their data traffic and have themselves deployed networks of Wi-Fi hotspots as a cost-effective alternative to traditional wireless services.[25] The availability of Wi-Fi off-load reportedly saved mobile operators an estimated $30-$90 billion investment in network infrastructure in 2012 that would have otherwise been required to handle this traffic.[26]

The unlicensed wireless market has also been a driver of innovation, providing new standards years before their introduction into specific-use markets. More than 1000 different industries rely on unlicensed wireless technology and more than 5,000 different types of devices have been created to meet evolving consumer demands. It is estimated that up to 2.5 billion cellular devices will be operating on licensed spectrum by 2020. At least 95% of these devices

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[22] Mark Cooper, Efficiency Gains and Consumer Benefits of Unlicensed Access to the Public Airwaves at 14 (January 2012), available at http://www.markcooperresearch.com/SharedSpectrumAnalysis.pdf.

[23] *Id.* at 9.

[24] *Id.* at 46.

[25] Andrew vonNagy, A Look Ahead to Possible Wi-Fi Industry Trends in 2011 (Revolution Wi-Fi, Dec. 21 2012), available at http://revolutionwifi.blogspot.com/2010/12/look-ahead-to-possible-wi-fi-industry.html; Richard Thanki, The Economic Significance of License-Exempt Spectrum to the Future of the Internet at 8 (June 2012), available at http://www.wirelessinnovationalliance.org/index.cfm?objectid=DC8708C0-D1D2-11E1-96E9000C296BA163 ("Thanki"); *see also* AT&T Wi-Fi Milestones, available at http://www.att.com/Common/about_us/pdf/wi-fi_timeline.pdf.

[26] Thanki at 9.

will also be using unlicensed connections, creating an annual value of $560 to $870 billion.[27] By 2020, the combined economic contribution of the Internet could reach $2.2 trillion per year, with unlicensed access technology expected to connect 95% of these devices.[28]

IV. THE COMMISSION SHOULD MAXIMIZE THE AMOUNT OF SPECTRUM AVAILABLE FOR UNLICENSED WHITE SPACE DEVICE USE IN THE TELEVISION BANDS

Certainly not all policies can be as successful as the authorization of unlicensed Wi-Fi use, but it is a standard to which all other spectrum uses should aspire and provides a reference point of what is possible. In the broadcast bands, the Commission's white space rules set the stage for extremely robust white space deployments, with the availability of significant spectrum for white space use in markets around the country, particularly in rural, underserved and unserved areas. As the Commission noted in the Incentive Auction NPRM, "there is considerable white space available now in many areas–more than 100 megahertz in some markets."[29] As with Wi-Fi, where there is 84 MHz of available spectrum (2.4 GHz – 2.4835 GHz), the Commission should aspire to maximize the availability of spectrum for unlicensed deployments in the broadcast bands.

As will be seen through these comments, there are multiple policies that the Commission can pursue to maximize the availability of spectrum in the broadcast bands for white space use. Where there is underutilized spectrum, either by geographic location or spectral inefficiency, there should be a policy to promote the use of alternative use cases or technologies that will efficiently deploy that spectrum. That was the philosophy behind the Commission's adoption of

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[27] *Id.* at 11.

[28] *Id.* at 57, 89.

[29] Incentive Auction NPRM, ¶ 233. The Commission noted, for example that in Wilmington, NC, there is 204 MHz available for white spaces use. *Id.*, n. 369.

a white space regime for the broadcast bands in the first place, and the Commission should build on that philosophy in the rules that it adopts in its implementation of the Spectrum Act, *i.e.*, adopting rules promoting innovative methods of using spectrum more efficiently through cognitive applications and technologies.

With respect to white space uses in particular, as discussed above, the Commission has emphatically concluded that the use of television white space for database-driven unlicensed, cognitive devices presents huge opportunities for innovation, spectral efficiency, competition, rural deployment, and broadband access, to name just a few. Rural deployments in unserved and underserved areas require greater geographic coverage to have sufficient customers per base station. In WSA's experience, less than 100 people per square mile requires technologies with greater range to obtain the required return on investment. With the exceptional propagation characteristics of the TV bands, TV white space devices are uniquely-well suited for rural deployments. If the Commission's goal is to foster robust broadband services and ensure that rural broadband succeeds and thrives, then it must maximize the availability of spectrum in the VHF and UHF bands for white space use, which have propagation characteristics well-matched for less dense, wide area, fixed deployments, on an unlicensed basis. This also has the added benefit of bringing price points per device down to levels that are commensurate with demand characteristics in rural markets.[30] The availability of unused spectrum in the broadcast bands (whether unlicensed, or licensed but unused) for the deployment of white space devices is key.

In the NPRM, the Commission expresses its intent to promote unlicensed spectrum use "to the bounds of our statutory authority" and indicates its expectation that "there will still be a

[30] It is worth noting that these bands are not as well-suited for mobile wireless applications since at these frequencies, devices need relatively large antennas that are not well-suited for small, handheld mobile devices, resulting in greater power dissipation, lower battery life and reduced device and spectral efficiencies. In contrast, larger and efficient antenna deployments are possible for devices used for fixed, outdoor and rural broadband use.

substantial amount of spectrum available for use by these devices in the remaining broadcast television channels after the incentive auction." It is not clear to WSA why the Commission believes this to be the case, and ensuring that sufficient white space spectrum remains for unlicensed use ultimately remains the Commission's responsibility.

As explained in the NPRM, following the reverse auction, and the repack of the remaining broadcasters, the recaptured spectrum will be auctioned for flexible wireless use. Under this scenario, there is nothing to indicate that there will be spectrum remaining for white spaces, unless the Commission is assuming that not all of the available spectrum will be successfully auctioned.

While WSA recognizes that the Spectrum Act places limits on the Commission's authority, to the same extent that its innovation, creativity and its forward thinking led to the creation of unlicensed TV band white spaces use in the first place, given the significant promise of white space deployments, the fact that TV band white space databases are authorized and in place with rules for devices and deployments specifically designed and tailored for the TV bands, and that numerous companies are today investing in and poised to launch new white space systems in the TV bands, the Commission must ensure the continued availability of significant swaths of contiguous spectrum in markets around the country to support the deployment of white space devices.

As discussed below, this can be accomplished, consistent with the Commission's statutory authority, by authorizing the opportunistic use of licensed spectrum by unlicensed cognitive radios, that together with geo-location databases, can operate on vacant, unassigned frequencies, *but also on frequencies that may be licensed to other broadband systems but are not in use*. In addition, WSA also supports the maximum availability of unlicensed spectrum in

licensed bands, which, together with vacant and unused channels in these bands, can provide additional bandwidth necessary to support robust white space networks.

As noted above, the white space rules alone require three contiguous channels for fixed operations and robust portable operations, and the proposals in the NPRM fall far short of this. As discussed below, the Commission's proposals on unlicensed spectrum in the TV bands are a start, and the WSA commends the Commission in its goal to create certainty of spectrum for unlicensed use on a nationwide basis through authorization of unlicensed use in newly-created guard bands, but the amount of spectrum it proposes to make available for unlicensed use in the guard bands is by no means sufficient. Moreover, regardless of whether a substantial amount of spectrum may remain available in rural and remote areas, there is no certainty of unlicensed spectrum availability in urban markets under the Commission's proposal, which would prevent the ability to achieve a nationwide coverage.

Thus, in addition to authorizing white space use in the guard bands and in unassigned and vacant channels, the Commission should also authorize white space use of licensed spectrum that is assigned but unused – the so-called "use it or share it" paradigm. In addition, the Commission should implement additional policies to maximize the potential availability of spectrum for white space, as discussed below. In these ways the Commission will ensure that the promise of white spaces that have been set in motion through its TV white space rules, will be fulfilled.

A. The Commission Should Authorize Opportunistic, "Use It or Share It" Access to Spectrum in the Broadcast Bands, Including Both Unassigned Licensed Spectrum and Spectrum that has Been Licensed But Remains Unused.

As the Commission recognizes in the NPRM (at ¶ 2), in addition to freeing up spectrum for wireless broadband through traditional approaches such as clearing and reallocating spectrum for wireless auctions, the Commission has also "enabled more efficient use of spectrum in numerous innovative ways." As noted, these include maintaining the availability of the TV bands for cognitive radio sharing technology, which, as the Commission recognizes and as discussed above, can spur innovation to address meaningful communications needs of consumers, businesses and governments.[31]

As the Commission recognizes, "This new approach is serving to make available spectrum that previously has laid fallow while also protecting the incumbent broadcast television and other services that use the VHF and UHF bands from interference."[32] The Commission indicates in the NPRM its expectation that, following the reverse auction, repack, and forward auction, "television white spaces will continue to be available for unlicensed use," but appears to be taking a myopic view of exactly what white spaces are and where white spaces devices can operate. Rather, as the universe of users in the television bands evolves from primarily television broadcast licensees to include commercial wireless providers, the Commission must ensure that spectrum that lays unused *anywhere in the TV bands*, whether because it is unlicensed or because it is unused, is available for white space device use, with appropriate interference protections for licensed services. Simply put, spectrum should not remain unused in the broadcast bands if there are radio technologies that can make opportunistic use of this

[31] NPRM, ¶¶ 228, 230.

[32] *Id.*, ¶ 230.

spectrum. Licensed use in the newly reconfigured broadcast bands should emphasize interference protection rather than the right to exclude other users where spectrum is not being used.

Thus, WSA agrees that the Commission should implement a "Use it or Share it" model for the broadcast bands following repacking and the forward auction.[33] Specifically, unused spectrum should be available in a geographic area on a localized basis for unlicensed white space use, both where a channel has been unassigned, or where a channel has been licensed, but the licensee is not using the spectrum to provide service. Accordingly, WSA supports the establishment of a regulatory framework permitting the use of license-exempt technologies and opportunistic use of licensed spectrum by cognitive license-exempt devices in the TV Bands.

Such a use it or share it model in the broadcast bands should be implemented through use of the white space database, and the registration of new deployments of wireless licensees in specific geographic areas as service is turned-up.[34] Thus, *all licensed uses should be included in the TV white space database as they are built out*, with unlicensed, white space use of the spectrum permitted until a licensee actually builds out and turns on a site serving a defined geographic area. The areas where "share it" operations are permitted should be determined on the basis of protected contours of locations that have been built-out and turned on, and should be smaller areas than the geographic licensing area adopted for spectrum auction and licensing purposes. Thus, for example, if the Commission determines to auction and assign licenses on the basis of Economic Areas ("EAs") as proposed in the NPRM,[35] each EA licensing area should be

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[33] NPRM, ¶ 405.

[34] *Id.*

[35] NPRM, ¶ 148. EAs are one or more economic nodes – typically metropolitan areas that serve as the center of economic activity and the surrounding counties that are economically related to those nodes. *Id.* The Commission

divided into subarea microcells that would be registered in the database and subject to protection as sites are built out and service deployed. However, prior to sites being built out, deployed and registered, the spectrum in the unregistered microcells would be available for unlicensed white space device use. Such unlicensed use should not be tied to a licensee's build-out term, and limited to whether the licensee has failed to deploy service at the end of the required build-out.[36] Rather, unlicensed white space device use should be permitted at any time until a licensee has built-out a defined geographic area and registers that area in the white space database.

Such an approach will provide for the efficient use of spectrum and will not disadvantage auction winners, as when they are ready to use the spectrum it will be available and subject to interference protection. However, until that time, efficient use spectrum policy dictates that opportunistic users can deploy white spaces technologies using those frequencies that are unused over the specified geographic areas.

This is fully consistent with approaches under consideration by the Commission for government users in the 3.6 GHz band based on a report and recommendations by the President's Council of Advisors on Science and Technology ("PCAST").[37] As the PCAST Report recognizes, "The norm for spectrum use should be sharing, not exclusivity."[38] Thus, the report recommends "a new 'dynamic sharing' model that makes spectrum sharing by Federal users the

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divides the United States into 172 EAs as developed by the Bureau of Economic Analysis of the U.S. Department of Commerce in 1995. NPRM, n. 225.

[36] NPRM, ¶ 405.

[37] Report to The President, *Realizing the Full Potential of Government-Held Spectrum to Spur Economic Growth* (PCAST, July 2012), *available at* http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast_spectrum_report_final_july_20_2012.pdf ("PCAST Report").

[38] *Id.* at vi.

norm, and also allows sharing with commercial users."[39] Like the white space database, the report recommends the creation of "a Federal Spectrum Access System (SAS) to serve as an information and control clearinghouse for the band-by-band registrations and conditions of use that will apply to all users with access to each shared Federal band under its jurisdiction."[40] In addition, as with TV white spaces, the approach will foster the development and deployment of low-cost, cognitive devices that can tune across a wide range of frequencies.[41]

In December 2012, the Commission adopted a notice of proposed rulemaking, proposing creation of just such a shared access approach in the 3550-3650 MHz government band.[42] There, deployments of government users in the 3.5 GHz band would be protected through the use of geo-location databases modeled on the TV white space database model.[43] Under the Commission's proposal, protected government users would register the coordinates of their locations in the database. After querying the database to ensure protection of the government users, "Licensed by rule" users would be permitted to operate authorized wireless broadband devices in areas where government facilities have not been deployed.[44]

WSA applauds this spectrum sharing approach in the 3.5 GHz government bands, and urges that the same model should be adopted for the reconfigured broadcast bands – protect the new wireless licensees where and when they deploy and register locations in the white space database, and allow unlicensed TV white space use in other areas. Thus, WSA recommends that

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[39] *Id.* at 15.

[40] *Id.*

[41] *Id.* at 17.

[42] *Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, GN Docket No. 12-354, FCC 12-148, Notice of Proposed Rulemaking (rel. Dec. 12, 2012).

[43] *Id.*, ¶ 95.

[44] *Id.*, ¶ 96, 101-102. "Licensed by rule" means that the particular use is authorized by a Commission rule, which obviates the need for an individual license. *Id.*, ¶ 62.

all newly licensed deployments covering the entire reconfigured TV bands covering all geographic areas should be registered in the TV white spaces database. This will create a greater transparency and facilitate efficient spectrum utilization. In addition, in this way, the Commission will maximize efficient spectrum utilization *and create disincentives for the speculative acquisition of spectrum, as well as parking and warehousing strategies, where a purchaser acquires spectrum for purposes other than its immediate deployment, and as a result, spectrum lays fallow, and remains underutilized.*

B. The Commission Should Implement Strategies that Maximize the Availability of Spectrum for Unlicensed White Space Device Use.

1. WSA Supports the Alternative Band Plan Set forth in Figure 12 of the NPRM, Rather than the Proposed Band Plan Set Forth in Figure 4.

Figure 4 of the NPRM sets forth the Commission's proposed band plan for the reconfigured 600 MHz band. As proposed in Figure 4, the Commission would establish a downlink block for wireless broadband commencing at Channel 36 (608 MHz), and extending downward based on the amount of spectrum reclaimed from broadcasters; and an uplink block commencing at Channel 51 (698 MHz) and also extending downward based on the amount of spectrum reclaimed from broadcasters. Upper and lower broadcast blocks would be established immediately below the uplink and downlink blocks, each separated by a 6 MHz guard band from the commercial bands. In addition, Channel 37 would establish what the Commission describes as a natural guard band between the uplink block and the upper broadcast block.

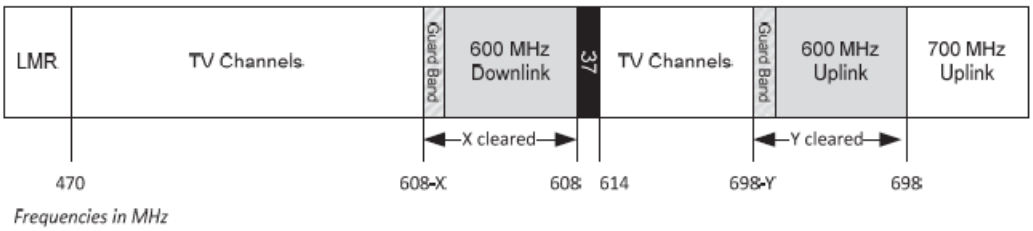


Figure 4. 600 MHz Band Plan

WSA has several concerns with this proposed band plan. As discussed above, under the Commission's white spaces rules, in order to protect broadcast operations, fixed white space devices require three contiguous channels to operate, and portable white space devices must operate at a lower power (40 mW) in the absence of three contiguous channels. Under the proposed band plan in Figure 4, by separating the remaining TV channels into two separate blocks, the Commission reduces the potential availability of triple channels, and hence channels available for white space device use. In addition, Channel 37, which would be sandwiched between the downlink block and the upper TV block, would be of utility for white space devices only to the extent that two adjacent channels (Channels 38 and 39) were available in the upper TV block. Similarly, guard band use for white space devices would be similarly limited. That is a guard band would only be of utility for white space devices to the extent there were two adjacent channels available at each edge of the respective TV broadcast block. Separating the broadcast channels into two blocks, reduces this possibility, and hence the potential availability of triple blocks of broadcast channels. The band plan proposed in Figure 4 is also suboptimal for commercial mobile operations given a large separation between the downlink and uplink bands, which may require different antenna sizes for optimal efficiency.

Instead, WSA supports the adoption of the alternative band plan set forth in Figure 12 of the NPRM. Under this proposal, the Commission would establish an uplink block beginning at Channel 51 (698 MHz) extending downward, followed by a duplex gap, and then a downlink block extending downward towards Channel 37 (614 MHz), followed by a guard band, and then a single broadcast block. The size of the uplink and downlink blocks, and how far the downlink block extends towards Channel 37 depends on the amount of spectrum reclaimed:

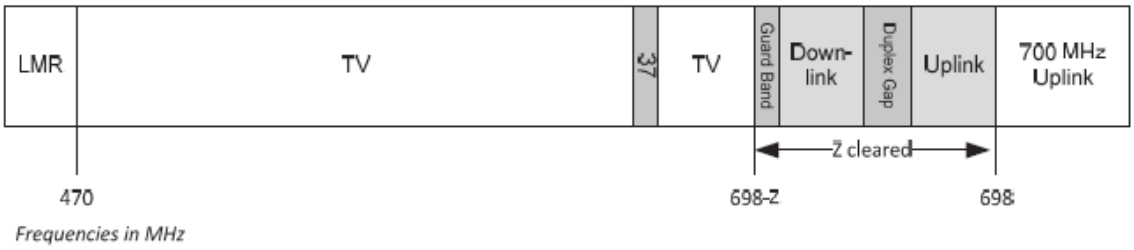


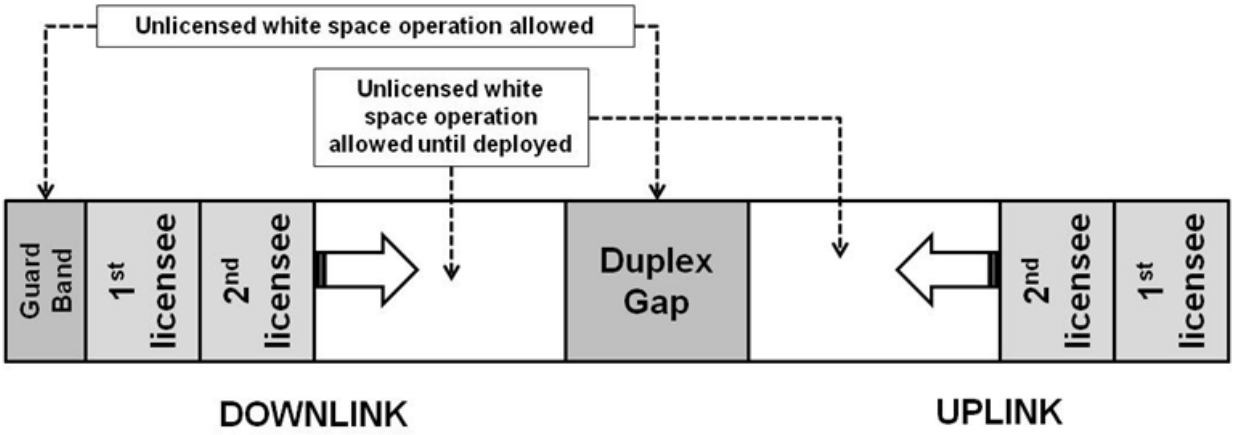
Figure 12. Alternative Approach, Down from 51

WSA believes this alternative band plan is preferable to the Commission's proposed plan for several reasons. First a single contiguous block of broadcast spectrum, that overlaps Channel 37, increases the potential availability of three contiguous channels in a market for white space device use. It also increases the potential utility of Channel 37 for white space device use for the same reason as there will be an increased likelihood of available TV channels on either side of Channel 37. The band plan proposed in Figure 12 is also preferable for commercial mobile since it would allow existing downlink and uplink transmitters to be re-purposed while keeping antenna efficiency at the mobile device high since the downlink and uplink would be proximately located to each other, separated only by a duplex gap.

WSA believes that a duplex gap, as a guard band, should be available for unlicensed white space device use. Moreover, given the likely width of the duplex gap greater than 6 MHz to protect uplink and downlink operations, and no constraint of a broadcast channel adjacency on either side of the duplex gap, the duplex gap will have potential greater utility for white space device use. *WSA recommends that the guard band size could be 10-12 MHz and duplex gap size could be 18-24 MHz to design filters for sufficient isolation between the downlink and the uplink.*

Most fundamentally, the Commission should implement a band plan and auction design that avoids segmenting and fragmenting frequency blocks, which wastes spectrum. Instead, licensees, including new wireless licensees, should be packed together in an orderly fashion at

the time of the deployment. Considering the alternative Band Plan in Figure 12 above, under this approach, the licensees would occupy the spectrum at deployment in the following sequence for each geographically identified area:



In addition, assuming that white space operations are permitted in the duplex gap and guard band, WSA recommends that the center of the duplex gap and the guard band frequencies could be harmonized across the U.S. Together with the "use it or share it" regime, this will serve to increase spectrum efficiencies and maximize the potential for the creation of vacant white space spectrum that will be available for white space device use, even in the licensed bands.

This approach would be facilitated by the Commission's auction design proposal, where there are multiple blocks of spectrum available in a market, to collect bids on one or more generic categories of licenses, rather than for a specific license.[45] In this way, the Commission can organize available blocks like parking spaces in a parking lot, and authorize deployment of those blocks contiguously, rather than allowing assigned channels to be scattered and fragmented.

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[45] NPRM, ¶ 56. Under this proposal, the FCC would announce prices for generic licenses in each category (such as paired or unpaired licenses) in each geographic area, and bidders would submit quantity bids for the number of licenses they seek. *Id.*, ¶ 60.

Thus, since it is not known who is going to deploy first in a particular market, WSA recommends that any winning bidder for a block of uplink or downlink spectrum in a geographic licensing area, be guaranteed the specified amount spectrum in the downlink and/or uplink, but not be given a specific frequency allocation until the time of deployment. Instead, frequency allocations would be implemented dynamically based on actual use and deployment in a given geographic licensing area as laid out in the figure above, which could be implemented through the use of a database-driven grant mechanism. In addition, in contrast to prior auctions, there will be no uniformity, and indeed significant variations, in channel availability and assignments across markets (as opposed to uniform blocks) based on any of the band plans, geographic licensing areas, and auction designs being considered by the Commission. Thus, under any scenario, winning bidders equipment will be required to select and operate on multiple channels across markets.

2. The Commission Should Make Channel 37 Available for Unlicensed Use.

In the NPRM, the Commission asks whether is should relocate Channel 37 incumbent radio astronomy service (RAS) and wireless medical telemetry system (WMTS) users and make the channel available for licensed wireless broadband, or retain Channel 37 for the current RAS and WMTS uses, and allow greater use of Channel 37 for unlicensed uses, such as white space devices.[46] WSA believes that it would make the most sense to retain Channel 37 for RAS and WMTS, but require these licenses to register with white space database providers in the areas where they are operating so that their operations can be protected. This would both preserve the integrity of Channel 37 for radio astronomy and WMTS, but allow for opportunistic use of the

[46] NPRM, ¶ 199.

spectrum by unlicensed white space devices in areas where the spectrum is not being used. Specifically, WSA suggests allowing white space devices to operate on Channel 37 subject to white space TV band database enforced exclusions in geographic regions where radio astronomy would be adversely affected by the operation of white space devices.

Similarly, as to WMTS, WMTS devices are registered in a database operated by the American Society of Healthcare Engineering (ASHE) of the American Hospital Association.[47] Given that WMTS devices are already registered in a database, WMTS locations could be imported into the TV white space databases, and TV white space devises could then protect WMTS locations, being free to operate in Channel 37 in other locations (subject to registered RAS locations). In addition, a separate protection contour should be adopted for WMTS from full service TV and other licensed broadcast users, reflecting the relatively small footprint of WMTS locations, while protecting WMTS from spurious emissions at registered locations.

3. The Commission Should Authorize the Use of Guard Bands of Increased Size and Any Duplex Gaps for White Space Device Use.

The Spectrum Act authorizes the Commission to establish guard bands that "shall be no larger than is technically reasonable to prevent harmful interference between licensed services outside the guard bands."[48] The Commission may allow unlicensed use of the guard bands, though the Commission may not allow unlicensed use of the guard bands that would cause harmful interference with licensed services.[49] Here, WSA believes, whatever band plan is ultimately adopted by the Commission, *that it should authorize operation of unlicensed white space devices in the guard bands between broadcast and commercial wireless spectrum.* In

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[47] The operation of WMTS transmitters are authorized within healthcare facilities and must be registered with ASHE, the FCC's designated frequency coordinator for WMTS. *See* 47 U.S.C. § 95.1107.

[48] Spectrum Act, § 6407(a).

[49] *Id.*, § 6407(c), (e).

addition, to the extent it adopts a band plan that provides for a duplex gap between uplink and downlink blocks *it should likewise authorize unlicensed white space device operations in the duplex gap*. These unlicensed operations should be authorized under rules similar to the rules in Part 15.247 to allow the most flexibility for unlicensed operations in these bands. In addition, WSA encourages the Commission to carefully review the interference issues between full power TV broadcasts and the commercial wireless uplink and downlink bands, as well as potential interference issues between the commercial wireless uplink and downlink bands.

WSA believes that guard bands need to be 10-12 MHz wide and the duplex gaps need to be 18-24 MHz wide, so as to allow filters that can provide sufficient isolation between the downlink and the uplink in these bands. This will also help to avoid interference from full power TV broadcasts into the proposed downlink and uplink spectrum, and vice versa, and provide for efficient filtering between downlink and uplink in these low frequency bands. The Commission should also take this opportunity to harmonize emission mask limits for both unlicensed and licensed devices in the television bands.

4. The Commission Should Use Small Geographic License Areas to License the 600 MHz Band for Wireless Broadband Use.

In the NPRM, the Commission proposes using a geographic area licensing approach, utilizing Economic Areas (EAs). As noted above,[50] EAs are medium-sized regional areas typically comprised of a metropolitan area and surrounding counties that are economically related. WSA believes it would be preferable to use smaller geographic license areas, such as Metropolitan Statistical Areas, Micropolitan Statistical Areas, and Metropolitan Divisions, together with new Rural Service Areas defined by the Commission, that are not included within

[50] *See, supra* n. 35.

Metropolitan and Micropolitan Statistical areas.[51] Creating such a granular approach, with the use of realistic reserve prices that recognize the value of spectrum for unlicensed use, *would create incentives for providers to bid on spectrum for particular geographic areas where they actually intend to deploy the spectrum, and leave what they do not*, greatly increasing the likelihood of large adjacent segments of available spectrum for unlicensed use in geographic areas around the country.[52] Such an approach would also minimize the obvious potential for spectrum warehousing with large geographic license areas, where a winning bidder intends to use only a segment of the license area – typically in the most dense urban area.

5. Repacking Broadcast Spectrum Needs To Consider Alternative Ways Of Freeing Up Excess Spectrum.

WSA recommends that effective broadcast deployment rules be developed to maximize spectrum utilization so as to increase the availability of spectrum for white space deployments. These include the following:

- When practical, TV broadcasters should be collocated on the same towers and cover common geographic areas and be relocated to occupy adjacent channels.
- One ATSC DTV transmitter can potentially multiplex more than one signal on the same channel. When TV Broadcasters are collocated, then they should be encouraged to multiplex their transmissions so as to improve spectral efficiency.

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[51] *See, e.g.*, OMB Bulletin No. 10-02, Update of Statistical Area Definitions and Guidance on Their Uses (Dec. 1, 2009), available at http://www.whitehouse.gov/sites/default/files/omb/assets/bulletins/b10-02.pdf. Metropolitan Statistical Areas have at least one urbanized area of 50,000 or more population, plus adjacent territory that has a high degree of social and economic integration. Micropolitan Statistical Areas, a new set of statistical areas, have at least one urban cluster of at least 10,000 but less than 50,000 population, plus adjacent territory that has a high degree of social and economic integration. Larger Metropolitan Statistical Areas are subdivided into smaller groupings referred to as Metropolitan Divisions. Together, these categories cover 94% of the U.S. population. *Id.* As it did in creating Cellular Market Areas, the Commission would also need to establish remaining Rural Service Areas (RSA), covering rural and remote areas of the United States not already included in the Metropolitan and Micropolitan Statistical Areas. *See Common Carrier Public Mobile Services Information, Cellular MSA/RSA Markets and Counties*, Public Notice, 7 FCC Rcd 742 (1992); Office of Engineering and Technology, FCC Areas, Cellular Market Areas, *available at* http://transition.fcc.gov/oet/info/maps/areas/.

[52] As the Commission puts it, smaller geographic licensing areas "could potentially support much greater variation in the amount of reclaimed spectrum from area to area." NPRM, ¶ 147.

- As suggested in Paragraph 30 of the NPRM, since LPTV stations have secondary interference protection rights, WSA recommends that the Commission give priority to the relocation of full power TV stations and allocate them to LPTV assignments that have not been deployed to free up maximum spectrum for unlicensed use. At the same time, the Commission should adopt and enforce more rigorous LPTV service requirements, so that the licenses of LPTV stations that are not truly operating and providing service in their markets should be cancelled. In addition, digital LPTV stations are currently protected from white space device use to the same contour as full service TV stations. LPTV stations should instead be protected to a contour that reflects their low power operation.

- In repacking the spectrum, TV Broadcast stations should be deployed as far away from the guard bands as possible to minimize interference to the new licensed mobile broadband services.

- WSA supports the Commission's proposal to use the Longley-Rice model, consistent with the Spectrum Act, for repacking broadcasters,[53] which is based on reality-based contours that are more spectrum efficient. In addition, if Longley-Rice is used for the broadcast repack, the Commission should likewise update its TV white space rules to apply Longley-Rice to TV white space protective contours as well. Preferably, NASA SRTM 2002 30m topo data should be used to establish real line of sight use of the band thus resulting in coverage/protection contours which are more realistic than probabilistic.

6. Aspects of the White Space Rules Should be Re-Examined So As to Further Increase the Availability of Spectrum for White Space Deployments.

(a) The Commission Should Revise its Rules Regarding Protection Zones Around Distant Cable and Satellite Receive Sites.

The Commission's white space rules currently protect cable TV headends and the receive sites of other multichannel video programming distributors ("MVPDs") such as direct broadcast satellite providers, that are located outside the protected contours of the TV stations being received, and allowing their registration in TV white space databases.[54] Generally, within an arc that is +/- 30 degrees between the protected receive site and the TV stations, white space devices

[53] *See* NPRM, ¶ 92, 98-99.

[54] *See* 47 C.F.R. §§ 15.703(j), 15.712(b).

may not operate co-channel 80 km from the receive site of a registered MVPD receive site, and on an adjacent channel 20 km from the receive site.[55]

Increasingly, however, the use of dedicated fiber optic links between these receive sites and TV stations renders this protection zone unnecessary. Thus, WSA believes that the Commission should re-examine the continued need for this protection zone, and at a minimum impose a deadline for fiber substitution and the phase-out of the protection. This will allow for additional white space spectrum to be productively deployed, primarily in rural areas, that would otherwise lay unused, and higher spectrum efficiency.

(b) The Commission Should Reduce the 6 MHz Adjacent-Channel Protection Rule for Fixed Uses to 3 MHz.

The Commission's white space rules generally prohibit fixed white space device operations on the first adjacent channel to a TV station. This provides a 6 MHz guard band around a TV station, and, as noted throughout these comments, effectively requires three contiguous channels ("triplets") for fixed white space operations, with a 6 MHz channel for operation, and a 6 MHz guard band on either side for protection. WSA believes that the Commission should re-examine this adjacent channel rule, particularly in view of the tight adjacent channel emission limit as adopted by the Commission in its white spaces rules,[56] and rather than prohibiting adjacent channel operations, reduce the 6 MHz adjacent channel protection rule for fixed uses, to 3 MHz.

Because white space devices allow for fractional channel tuning, this would significantly increase spectrum available for white space deployments in two respects. First, in contrast to the current situation where triplets are required for fixed white space deployments, if the guard band

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[55] *Id.*

[56] *See Third White Spaces Reconsideration Order*, ¶ 31.

were reduced to 3 MHz, only two channels would be required on either side of a TV station. The result would allow white space deployments over a far greater range of scenarios where there are two vacant channels, as opposed to the need to find triplets. In addition, where there are triplets, 12 MHz of spectrum would be available for operations over the 18 MHz block (with 3 MHz unused on either side). This is in contrast to the current scenario where even with a triplet, only 6 MHz would be available in the center channel, with the two end channels remaining vacant for protection. Thus, if 3 MHz guard band granularity is considered, then even 12 MHz contiguous spectrum for rural broadband (or two channels) will be able to deploy a fixed wireless system. Hence, all the doubles become usable and the capacity in all the triplets can be doubled.

C. Wireless Microphone Issues.

1. Wireless Microphones Should Be Required To Transition To More Spectrally Efficient Modulation and Bands.

In the NPRM, the Commission asks whether there are additional steps that it should take to promote more efficient or effective operations of wireless microphones in the broadcast bands. WSA believes that all wireless microphones should be required by a date certain to switch to more spectrally efficient modulation. In addition, as part of this transition to a more spectrally efficient scheme, WSA recommends that all wireless microphones authorized for licensed use become frequency agile, i.e., have the ability to dynamically select available spectrum on which to operate. Under this approach, (1) manufacturers should be given a timeline to manufacture alternate modulation scheme microphones; (2) a cut-off date needs to be established for the sale of analog microphones; and (3) a timeline needs to be set for broadcasters to deploy spectrally efficient microphones.

Moreover, if wireless microphones coordinate and assign themselves efficiently, even with analog microphones, approximately 15 microphones can be operated on a single TV

channel – with re-use of that channel over short distances, (that can be even closer together if the adjacent uses are an indoor venue). This of course becomes even more true with a digital microphone transition, that, as noted, with high-density digital microphones increases to about 47 microphones per channel.

2. The Commission Should Make Available The Two Designated Wireless Microphone Channels for Unlicensed Use, and the Availability of those Channels for Wireless Microphone Use Should Sunset.

Under the current TV white space rules, white space device operations are prohibited on the first channel above and the first channel below Channel 37 (608-614 MHz) that are available, or if a channel is not available above and below channel 37, white space device operation is prohibited on the first two channels nearest to channel 37.[57] In the NPRM, the Commission seeks comment on whether it should maintain these channels for wireless microphone use, or whether this spectrum should be made available for unlicensed use by white space devices.[58] As noted above, WSA supports unlicensed use of the guard bands and duplex gap in the band plan ultimately adopted by the Commission. This would include unlicensed use by wireless microphones. In that case, the two channels around Channel 37 that had been reserved for exclusive wireless microphone use, should be made available for unlicensed white space device use, as well.

The fact is that wireless microphones do not need the reserve channels as they have more than enough non-TV white space channels to choose from. This is because, historically, wireless microphones users have coordinated their frequency assignments with broadcasters. In many cases wireless microphones use channels that are adjacent to the TV broadcast channels that are,

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[57] *Second White Spaces Reconsideration Order*, ¶¶ 25-36.

[58] NPRM, ¶ 238.

as such, unusable by the 4W and 100 mW white space devices. WSA also understands that indoor wireless microphone users have also been found to prefer channels that are co-located with another TV broadcast channel that is geographically separated.

Over time, WSA believes that new frequencies (*e.g.*, 3.5 GHz and 4.9 GHz spectrum) should be identified for wireless microphone use. Much more spectrum is available in these higher bands that are ideal for short range communications, and wireless microphones would be equally well-served in higher frequencies because of their mode of operation. Hence, as part of the reconfiguration of the broadcast bands, the Commission should establish a timetable for transition of unlicensed wireless microphones out of the broadcast bands, altogether.

3. Licensed Part 74 Wireless Microphones, and Unlicensed Wireless Microphones that the Commission Has Authorized to Register Should Continue To Register In The White Spaces Database, and Wireless Microphones Should be Required to First Use Non-White Space Channels.

WSA recommends that the licensed Part 74 wireless microphones, and events and venues utilizing unlicensed wireless microphones that the Commission has authorized to register, should continue to be provided protection through registration in the TV white spaces database. When a licensed Part 74 devices is not utilizing a particular channel, the user should be required to update the availability of that channel, then the channel could be made available for unlicensed white space operation. Otherwise, since unlicensed wireless microphones with a temporary waiver pending resolution of the Commission's wireless microphone docket, fall into the Part 15 category, they should abide by the Part 15 rules where they accept interference while not causing interference to others. These unlicensed Part 15 wireless microphones should be treated like any other unlicensed white space device that uses, but is not protected through the white space database.

Moreover, wireless microphones should be required to use non-TV white space channels first (e.g., co- and adjacent channels to licensed TV boadcast channels) – and then be permitted to register/reserve a TV white space channel only if the available non-TV white space channel (including co-channels) are insufficient for an event/place/time.[59] Thus, if wireless microphones do need a TV white space channel reservation, the user must request that assignment from a TV white space database, which can ensure that a single white space channel is packed before blocking off a second one. Without the above limitation, wireless microphone operators would have the ability to spread out across the available TV white space channels, precluding white space use.

V. CONCLUSION

WHEREFORE, as set forth more fully in these comments, in implementing the Spectrum Act and adopting rules for the reverse auction, broadcast spectrum repack, and forward auction, the Commission should recognize the substantial benefits that flow from unlicensed white space deployments in the broadcast bands. Consistent with its statutory authority, the Commission should adopt rules that maximize the continued availability of significant contiguous blocks of spectrum for unlicensed operation in the TV bands, and authorize the opportunistic use by white space technologies of both unlicensed channels, and licensed, but *unused* channels. In this manner, the Commission will foster the demonstrated benefits of unlicensed white space

[59] For example, WSA understands, that as a practical matter, wireless microphones often operate, in coordination with broadcasters, co-channel to distant broadcast channels that may not be open to TV white space devices.

spectrum operations, including as engines of technological innovation, efficient spectrum utilization, and competition in broadband markets.

Respectfully submitted,
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ATTACHMENT A

WhiteSpace Alliance

EXAMPLES OF RECENT WHITE SPACE DEVELOPMENTS

ADAPTRUM

1. Cambridge White Space Trials.

Adaptrum (www.adaptrum.com) deployed a base station and multiple clients throughout Cambridge UK as part of the Cambridge white space trials. The BBC and Arquiva led the test and measurement using extensive human resources and monitoring equipment to understand the potential opportunities and challenges offered by the emerging uses of the TV white spaces.

The Cambridge base station operated under non-operational licenses issued for test and development by Ofcom. A total of 10 TV channels have been allocated for the trial for low power operation (EIRP <4W). The base station (BS) was deployed mostly at the Lion & Lamb PH in Milton. The measurements were made at a number of test points at 10m and 1.5m height, in order to simulate fixed/nomadic customer premises equipment (CPE) and mobile user equipment (UE) applications.

- The results show the 125 mW base station achieved a coverage of up to 1.5km for fixed reception at 10m and around 400m for mobile reception at the coverage edge.

- Throughput analysis, revealed a useful TCP-IP bandwidth of between 7Mb/s and 1Mb/s, dependent on the received signal levels. 2 bits per hertz without multiple-input, multiple-output ("MIMO") is expected, and double that for MIMO.

2. Additional Global Deployments of White Space Systems

Adaptrum has been doing deployments around the world. Below represents some of the more recent deployments.

•Microsoft NAB Demo (Las Vegas)	4/10/2011
•Cambridge Trial Launch Demo (UK)	6/29/2011
•IGF Demo (Kenya, Africa)	9/26/2011
•IDA Demo (Singapore)	1/16/2012
•Cambridge Field Testing (UK)	3/7/2012
•IDB Demo (Montevideo, Uruguay)	3/16/2012

•Asia Demo (Philippines, KL, Japan)	4/12/2012
•FCC Certification	4/19/2012
•Commercial Deployment VA, USA	6/23/2012
•Singapore Live Demo SWSPG	9/4/2012

3. FCC Certification of White Space Equipment

On April 23, 2012, the FCC certified Adaptrum's ACRS 1.0 TV white space system as fixed TV band devices operating together with the Telcordia TV white space database on April 19, 2012. The operation was approved for the entire UHF TV band (Channel 14 to 51, from 470 MHz to 698 MHz) and authorized for a radiated output power close to 4 W EIRP (with more than 0.5 W conducted output power and up to 10 dBi antenna gain.) The ACRS 1.0 system is built upon Adaptrum's innovative cognitive radio technology with an Adaptive OFDM engine offering superior flexibility, (throughput/range) performance and interference resilience. It features an output signal that meets the stringent FCC TV band device emission requirements while maximizing channel spectrum efficiency (> 5.5 MHz/6MHz). *See* http://www.prnewswire.com/news-releases/adaptrum-announces-fcc-certified-super-wi-fi-solution-and-launch-of-commercial-trial-in-virginia-148517495.html

4. Nottoway, Virginia Commercial Trial

As a first step towards commercialization, Adaptrum in partnership with Stratcom and Telcordia is launching a commercial TV white space trial in the rural county of Nottoway, Virginia. The trial will provide high-speed wireless broadband service in underserved areas in Nottoway County especially targeting rural schools and households. The trial will use the ACRS 1.0 system together with Telcordia TV white space database. Stratcom is the local partner in this trial representing the County and State and will be responsible for service deployment and project management. A total of 20 sites including 3 base station sites and 17 client sites are planned. Different use cases of the TV white space technology will be studied, especially focusing on education-related applications.

Cambridge UK Test & Measurement

Test Sites in Cambridge

Rural Deployment in Nottaway VA

SPECTRUM BRIDGE

Content Distribution and Digital Signage. SpectrumBridge is completing certification of a radio from Meld Technology (http://www.meldtech.com/) which is a white space TV broadcast solution. The market is convention centers, hotels, schools, shopping malls, big box stores, which stream content over a vacant TV channel to any commercial off the shelf TV that is within range.

Farm Automation. The big agri-business suppliers have been automating farm machinery and functions to minimize use of fertilizer, pesticides and water while maximizing yields. What was missing was the umbilical link back to the command and control center. Non line-of-sight environments where they typically operate (for example, orchards and groves), presented typical challenges. These issues were overcome by TV white space devices, which closed these umbilical links and allowed for the deployment of practical solutions.

In 2012, these solutions were integrated and proved-out, and it is expected that in 2013 TV white space devices will be deployed as part of many hundreds, eventually thousands, of these automated farming solutions. SpectrumBridge is also in the final stages of planning at least one of these farm automation solutions in Canada, which is targeted for deployment in Spring 2013. Building on the agri-business solution, the company is also looking at similar applications in forestry and mining, as well for large industrial applications.

Portable WiFi. SpectrumBridge has deployed a number of trials of a portable Wi-Fi application that uses TV white spaces for backhaul. The application is for large areas, *e.g.*, a depot or equipment dealership, where it would take ten to fifteen Wi-Fi hotspots to provide basic coverage. These type of facilities require the coverage for nomadic applications such as asset tracking. A Wi-Fi application packaged with a TV white space device can be carried or left in a vehicle that roams to particular areas. The devices then connect locally to a single application that is backhauled using white spaces. This results in a much simpler and cost-effective solution than other wireless applications.

CARLSON WIRELESS TECHNOLOGIES, LLC

1. Yurok Community White Space Trials

The Yurok Reservation stretches 44 miles along the Klamath-Trinity River in Del Norte and Humboldt counties, located in the rural northwest corner of California. Internet access on the Reservation has been extremely limited thanks to its rugged terrain and remote location. Mountains and deep river valleys prohibited traditional microwave solutions. The tribe, including its public safety agencies, was forced to share a single T1 line, causing communications bottlenecks and slower than dial-up connections.

That began to change on January 26, 2011 when the FCC granted the experimental license allowing Carlson's TV white space trial project to move forward. Now the Yurok community has a dedicated public safety line, offering up to 7 Mbps and allowing faster access to criminal databases. Soon it will also have the ability to conduct live video training with their fire fighters, support clinics that can perform virtual telemedicine, and implement an emergency services plan that is completely self-sufficient.

This TV white space trial has already transformed the Yurok community's public safety communications system and has paved the way for other Tribes to follow.

Yurok Tribal Territory

- 40+ square miles along the mouth of the Klamath River
- Very rugged terrain
  - Mountainous
  - Heavily forested
- Scattered, remote population
- Cultural prohibition on visible infrastructure

- Carlson team picked locations for 3 major access points that could be hidden in trees
- UHF signal reached well into obscured areas
- Immediate benefits
- Installed dedicated **public safety** lines to **fire station**, elementary **school** and **tribal administration** building

2. **<u>Other Carlson Trials</u>**

   a. Rural New England
      - Low teledensity = low fiber miles
      - Active role for WISP's in CT, MA and VT
      - Hilly, forested landscape
      - Hundreds of "failed installs" historically in Vermont, Connecticut and Massachusetts
      - Pressure from the community to serve all

- State and local government active and supportive
- Vermont Gov. Peter Shumlin personally behind rural connectivity

b. Water/Waste Water Utility, Tennessee
   - Data collection needed from 2 remote, low lying hollows.
   - Connectivity critical to meet regulatory reporting requirements
   - Required non line-of-site capabilities, but also desired higher throughput for video monitoring

c. Oklahoma
   - WISP with hundreds of failed installs in three Oklahoma counties
   - Using water tower to hit failed microwave sites
   - Also, local TV station offers tower for interference test